U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-258 249

Lake Ahquabi
Warren County, Iowa

Pacific Northwest Environmental Research Lab, Corvallis, Oreg

Prepared for

Iowa Dept of Environmental Quality, Des Moines

Aug 76

288066

PB 258 249

U.S. ENVIRONMENTAL PROTECTION AGENCY
NATIONAL EUTROPHICATION SURVEY

WORKING PAPER SERIES

CORVALLIS ENVIRONMENTAL RESEARCH LABORATORY - CORVALLIS, OREGON

and

ENVIRONMENTAL MONITORING & SUPPORT LABORATORY - LAS VEGAS, NEVADA

REPRODUCED BY
NATIONAL TECHNICAL
INFORMATION SERVICE
U. S. DEPARTMENT OF COMMERCE
SPRINGFIELD, VA. 22161

☆G.P.O. 699-440

REPORT

ON

LAKE AHQUABI

WARREN COUNTY

IOWA

EPA REGION VII

WORKING PAPER No. 494

WITH THE COOPERATION OF THE

IOWA DEPARTMENT OF ENVIRONMENTAL QUALITY

AND THE

IOWA NATIONAL GUARD

AUGUST, 1976

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FOREWORD

The National Eutrophication Survey was initiated in 1972 in response to an Administration commitment to investigate the nationwide threat of accelerated eutrophication to freshwater lakes and reservoirs.

OBJECTIVES

The Survey was designed to develop, in conjunction with state environmental agencies, information on nutrient sources, concentrations, and impact on selected freshwater lakes as a basis for formulating comprehensive and coordinated national, regional, and state management practices relating to point-source discharge reduction and non-point source pollution abatement in lake watersheds.

ANALYTIC APPROACH

The mathematical and statistical procedures selected for the Survey's eutrophication analysis are based on related concepts that:

a. A generalized representation or model relating sources, concentrations, and impacts can be constructed.

b. By applying measurements of relevant parameters associated with lake degradation, the generalized model can be transformed into an operational representation of a lake, its drainage basin, and related nutrients.

c. With such a transformation, an assessment of the potential for eutrophication control can be made.

LAKE ANALYSIS

In this report, the first stage of evaluation of lake and watershed data collected from the study lake and its drainage basin is documented. The report is formatted to provide state environmental agencies with specific information for basin planning [§303(e)], water quality criteria/standards review [§303(c)], clean lakes [§314(a,b)], and water quality monitoring [§106 and §305(b)] activities mandated by the Federal Water Pollution Control Act Amendments of 1972.

TECHNICAL REPORT DATA
(Please read Instructions on the reverse before completing)

1. REPORT NO.	2.
	3. RECIPIENT'S ACCESSION NO.
4. TITLE AND SUBTITLE Report on Lake Ahquabi, Warren County, Iowa	5. REPORT DATE Prepared August 1976 6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S) Anonymous (National Eutrophication Survey Staff)	8. PERFORMING ORGANIZATION REPORT NO. Working Paper # 494
9. PERFORMING ORGANIZATION NAME AND ADDRESS National Eutrophication Survey U.S. Environmental Protection Agency 200 S. W. 35th St. Corvallis, Oregon 97330	10. PROGRAM ELEMENT NO. 11. CONTRACT/GRANT NO.
12. SPONSORING AGENCY NAME AND ADDRESS Office of Research and Development U.S. Environmental Protection Agency 401 M Street, S. W. Washington, DC 20460	13. TYPE OF REPORT AND PERIOD COVERED Final - 1974 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES
Prepared in cooperation with the U.S. Environmental Protection Agency, National Environmental Research Center, Las Vegas, Nevada 89114

16. ABSTRACT

Annual total phosphorus and total nitrogen loadings to the lake were estimated and subdivided according to either point or non-point source origin. An assessment of the lake's trophic condition and limiting nutrient is also provided. All data collected by the U.S.E.P.A. National Eutrophication Survey during the one year study of the lake and its tributaries are included in the report.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
eutrophication lakes nutrients phosphorus nitrogen loading		05B 05C

PRICES SUBJECT TO CHANGE

18. DISTRIBUTION STATEMENT Release unlimited 1a	19. SECURITY CLASS *(This Report)* 20. SECURITY CLASS *(This page)*	21. NO. OF PAGES 34 22. PRICE 4.00/3.00

EPA Form 2220-1 (9-73)

Beyond the single lake analysis, broader based correlations between nutrient concentrations (and loading) and trophic condition are being made to advance the rationale and data base for refinement of nutrient water quality criteria for the Nation's freshwater lakes. Likewise, multivariate evaluations for the relationships between land use, nutrient export, and trophic condition, by lake class or use, are being developed to assist in the formulation of planning guidelines and policies by EPA and to augment plans implementation by the states.

ACKNOWLEDGMENT

The staff of the National Eutrophication Survey (Office of Research & Development, U. S. Environmental Protection Agency) expresses sincere appreciation to the Iowa Department of Environmental Quality for professional involvement, to the Iowa National Guard for conducting the tributary sampling phase of the Survey, and to those wastewater treatment plant operators who voluntarily provided effluent samples and flow data.

The staff of the Water Quality Division of the Department of Environmental Quality provided invaluable lake documentation and counsel during the Survey, reviewed the preliminary reports, and provided critiques most useful in the preparation of this Working Paper series.

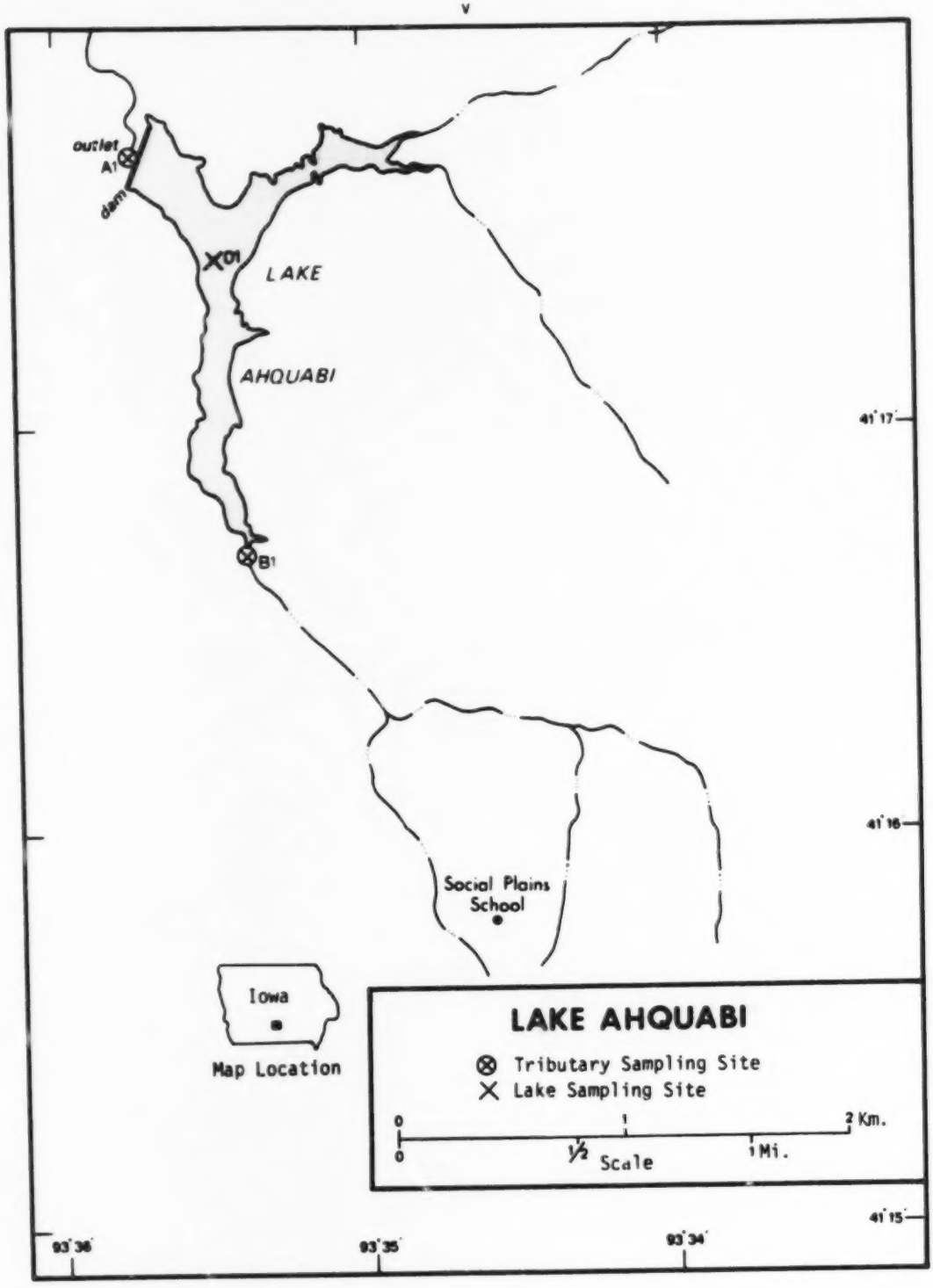
Major General Joseph G. May, the Adjutant General of Iowa, and Project Officer Colonel Cleadeth P. Woods, who directed the volunteer efforts of the Iowa National Guardsmen, are also gratefully acknowledged for their assistance to the Survey.

NATIONAL EUTROPHICATION SURVEY

STUDY LAKES

STATE OF IOWA

LAKE NAME	COUNTY
Ahquabi	Warren
Big Creek Reservoir	Polk
Black Hawk	Sac
Clear	Cerro Gordo
Darling	Washington
Lost Island	Clay, Palo Alto
MacBride	Johnson
Prairie Rose	Shelby
Rathbun Reservoir	Appanoose, Wayne
Red Rock Reservoir	Marion
Rock Creek	Jasper
Silver	Worth
Spirit	Dickinson
Viking	Montgomery
West Okoboji	Dickinson


outlet
A1
dam
X01
LAKE
AHQUABI
B1
41°17'
41°16'
Social Plains
School
Iowa
Map Location
LAKE AHQUABI
Tributary Sampling Site
Lake Sampling Site
0
1
2 Km.
0
½
Scale
1 Mi.
41°15'
93°36'
93°35'
93°34'

LAKE AHQUABI

STORET NO. 1901

I. CONCLUSIONS

A. Trophic Condition:

Survey data indicate that Lake Ahquabi is eutrophic. It ranked third in overall trophic quality when the 15 Iowa lakes and reservoirs sampled in 1974 were compared using a combination of six parameters*. Six of the water bodies had less median total phosphorus, three had less dissolved orthophosphorus, seven had less median inorganic nitrogen, none had less mean chlorophyll a, and eight had greater mean Secchi disc transparency. Significant depression of dissolved oxygen with depth was not detected at any sampling time.

B. Rate-Limiting Nutrient:

The algal assay results indicate that the primary productivity of Lake Ahquabi was limited by phosphorus at the time the sample was collected (04/17/74). The lake data indicate phosphorus limitation in September as well.

C. Nutrient Controllability:

1. Point sources--No municipal or industrial point-sources contributed phosphorus to Lake Ahquabi during the sampling year. Septic tanks were estimated to have contributed 1.8% of the total phosphorus load, but a shoreline survey would be necessary to determine the actual significance of those sources.

The present phosphorus loading of 1.02 $g/m^2/yr$ is over 2½ times

* See Appendix A.

that proposed by Vollenweider (Vollenweider and Dillon, 1974) as a eutrophic loading (see page 11). If the present phosphorus loading is not reduced, it is likely that the existing trophic quality of the lake will deteriorate.

2. Non-point sources--Approximately 98% of the total phosphorus input to Lake Ahquabi during the sampling year came from non-point sources. Unnamed Stream B-1 contributed 45.4% of the total, and the contribution of unsampled tributaries was estimated to have been 51.0%.

The phosphorus export rate of Unnamed Stream B-1 was 42 kg/km^2/yr (see page 10). This rate is higher than the rate of a tributary of Rathbun Lake* (36 kg/km^2/yr) but lower than the rates of two of the tributaries of nearby Red Rock Reservoir** (68 and 78 kg/km^2/yr).

The watershed of Lake Ahquabi is intensively farmed, and agricultural runoff probably contributes a large part of the total non-point phosphorus load to the lake. In view of the apparent minimal impact of point sources, it appears that any significant improvement in the trophic condition of the lake will depend on control of agricultural phosphorus contributions.

* Working Paper No. 502.
** Working Paper No. 503.

II. LAKE AND DRAINAGE BASIN CHARACTERISTICS†

A. Lake Morphometry††:

1. Surface area: 0.53 kilometers^2.
2. Mean depth: 3.0 meters.
3. Maximum depth: 6.6 meters.
4. Volume: 1.590 x 10^6 m^3.
5. Mean hydraulic retention time: 263 days.

B. Tributary and Outlet:
(See Appendix C for flow data)

1. Tributaries -

Name	Drainage area (km^2)*	Mean flow (m^3/sec)*
Unnamed Stream B-1	5.8	0.03
Minor tributaries & immediate drainage -	6.5	0.04
Totals	12.3	0.07

2. Outlet -

Unnamed Stream A-1	12.8**	0.07

C. Precipitation***:

1. Year of sampling: 75.8 centimeters.
2. Mean annual: 83.2 centimeters.

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† Table of metric conversions--Appendix B.
†† Harrison, 1975.
* For limits of accuracy, see Working Paper No. 175, "...Survey Methods, 1973-1976".
** Includes area of lake.
*** See Working Paper No. 175.

III. LAKE WATER QUALITY SUMMARY

Lake Ahquabi was sampled three times during the open-water season of 1974 by means of a pontoon-equipped Huey helicopter. Each time, samples for physical and chemical parameters were collected from three depths at one station on the lake (see map, page v). During each visit, a single depth-integrated (near bottom to surface) sample was collected for phytoplankton identification and enumeration, and a similar sample was collected for chlorophyll *a* analysis. During the first visit, a single 18.9-liter depth-integrated sample was taken for algal assays. The maximum depth sampled was 4.3 meters.

The sampling results are presented in full in Appendix D and are summarized in the following table (the July nutrient samples were not properly preserved and were not analyzed).

A. SUMMARY OF PHYSICAL AND CHEMICAL CHARACTERISTICS FOR LAKE ACQUABI
STORET CODE 1901

PARAMETER	1ST SAMPLING (4/17/74) 1 SITES RANGE	MEAN	MEDIAN	2ND SAMPLING (7/ 2/74) 1 SITES RANGE	MEAN	MEDIAN	3RD SAMPLING (9/25/74) 1 SITES RANGE	MEAN	MEDIAN
TEMP (C)	10.2 - 12.3	11.3	11.4	25.5 - 26.3	25.9	25.9	17.0 - 17.1	17.0	17.0
DISS OXY (MG/L)	9.6 - 10.0	9.8	9.8	7.0 - 7.8	7.5	7.7	6.8 - 7.2	7.1	7.2
CNDCTVY (MCROMO)	37. - 145.	86.	77.	271. - 271.	271.	271.	187. - 188.	187.	187.
PH (STAND UNITS)	****** -**********			7.8 - 7.9	7.8	7.8	7.4 - 7.4	7.4	7.4
TOT ALK (MG/L)	104. - 104.	104.	104.	****** -**********			100. - 103.	101.	101.
TOT P (MG/L)	0.038 - 0.060	0.048	0.046	****** -**********			0.064 - 0.074	0.069	0.068
ORTHO P (MG/L)	0.009 - 0.011	0.010	0.009	****** -**********			0.009 - 0.010	0.009	0.009
NO2+NO3 (MG/L)	0.470 - 0.520	0.503	0.520	****** -**********			0.020 - 0.020	0.020	0.020
AMMONIA (MG/L)	0.040 - 0.060	0.053	0.060	****** -**********			0.120 - 0.140	0.130	0.130
KJEL N (MG/L)	0.700 - 1.100	0.867	0.800	****** -**********			0.800 - 1.000	0.867	0.800
INORG N (MG/L)	0.510 - 0.580	0.557	0.580	****** -**********			0.140 - 0.160	0.150	0.150
TOTAL N (MG/L)	1.220 - 1.620	1.370	1.270	****** -**********			0.820 - 1.020	0.887	0.820
CHLRPYL A (UG/L)	6.8 - 6.8	6.8	6.8	6.7 - 6.7	6.7	6.7	12.3 - 12.3	12.3	12.3
SECCHI (METERS)	0.8 - 0.8	0.8	0.8	0.3 - 0.3	0.3	0.3	1.2 - 1.2	1.2	1.2

B. Biological characteristics:

1. Phytoplankton -

Sampling Date	Dominant Genera	Algal Units per ml
04/17/74	1. *Synedra sp.*	475
	2. Centric diatoms	277
	3. *Asterionella sp.*	198
	4. *Aphanizomenon sp.*	158
	5. *Nitzschia sp.*	119
	Other genera	118
	Total	1,345
07/02/74	1. *Trachelomonas sp.*	627
	2. *Anabaena sp.*	575
	3. Centric diatoms	314
	4. *Microcystis sp.*	105
	5. *Schroederia sp.*	105
	Other genera	208
	Total	1,934
09/25/74	1. *Oscillatoria sp.*	768
	2. *Melosira sp.*	384
	3. *Aphanizomenon sp.*	154
	4. *Trachelomonas sp.*	115
	5. *Anabaena sp.*	77
	Other genera	153
	Total	1,651

2. Chlorophyll *a* -

Sampling Date	Station Number	Chlorophyll *a* (µg/l)
04/17/74	1	6.8
07/02/74	1	6.7
09/25/74	1	12.3

C. Limiting Nutrient Study:

1. Autoclaved, filtered, and nutrient spiked -

Spike (mg/l)	Ortho P Conc. (mg/l)	Inorganic N Conc. (mg/l)	Maximum yield (mg/l-dry wt.)
Control	0.015	0.540	9.0
0.050 P	0.065	0.540	22.0
0.050 P + 1.0 N	0.065	1.540	37.0
1.0 N	0.015	1.540	10.3

2. Discussion -

The control yield of the assay alga, Selenastrum capricornutum, indicates that the potential primary productivity of Lake Ahquabi was high at the time the sample was taken (04/17/74). Also, the addition of orthophosphorus alone resulted in a significant increase in yield indicating that the lake was phosphorus limited at that time. Note that the addition of only nitrogen resulted in a yield not significantly greater than that of the control.

The lake data substantiate phosphorus limitation. The mean inorganic nitrogen to orthophosphorus ratios were 56 to 1 and 17 to 1 in April and September, respectively, and phosphorus limitation would be expected.

IV. NUTRIENT LOADINGS
(See Appendix E for data)

For the determination of nutrient loadings, the Iowa National Guard collected monthly near-surface grab samples from each of the tributary sites indicated on the map (page v). Sampling was begun in December, 1974, and was completed in June, 1975.

Through an interagency agreement, stream flow estimates for the year of sampling and a "normalized" or average year were provided by the Iowa District Office of the U.S. Geological Survey for the tributary sites nearest the lake.

In this report, nutrient loads for sampled tributaries were determined by using a modification of a U.S. Geological Survey computer program for calculating stream loadings*.

Nutrient loads for unsampled "minor tributaries and immediate drainage" ("ZZ" of U.S.G.S.) were estimated using the nutrient loads at station B-1, in $kg/km^2/year$, and multiplying by the ZZ area in km^2.

No wastewater treatment plants impacted Lake Ahquabi during the sampling year.

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* See Working Paper No. 175.

A. Waste Sources:

1. Known municipal - None

2. Known industrial - None

B. Annual Total Phosphorus Loading - Average Year:

1. Inputs -

Source	kg P/ yr	% of total
a. Tributaries (non-point load) -		
Unnamed Stream B-1	245	45.4
b. Minor tributaries & immediate drainage (non-point load) -	275	51.0
c. Known municipal STP's - None	-	-
d. Septic tanks* -	10	1.8
e. Known industrial - None	-	-
f. Direct precipitation** -	10	1.8
Total	540	100.0

2. Outputs -

Lake outlet - Unnamed Stream A-1 180

3. Net annual P accumulation - 360 kg.

* Estimate based on four parks, two campgrounds, and one resort; see Working Paper No. 175.
** See Working Paper No. 175.

C. Annual Total Nitrogen Loading - Average Year:

1. Inputs -

Source	kg N/yr	% of total
a. Tributaries (non-point load) -		
Unnamed Stream B-1	4,900	43.2
b. Minor tributaries & immediate drainage (non-point load) -	5,495	48.4
c. Known municipal STP's - None	-	-
d. Septic tanks* -	390	3.4
e. Known industrial - None	-	-
f. Direct precipitation** -	570	5.0
Total	11,355	100.0

2. Outputs -

Lake outlet - Unnamed Stream A-1 4,290

3. Net annual N accumulation - 7,065 kg.

D. Non-point Nutrient Export by Subdrainage Area:

Tributary	kg P/km^2/yr	kg N/km^2/yr
Unnamed Stream B-1	42	845

* Estimate based on four parks, two campgrounds and one resort; see Working Paper No. 175.
** See Working Paper No. 175.

E. Yearly Loads:

In the following table, the existing phosphorus loadings are compared to those proposed by Vollenweider (Vollenweider and Dillon, 1974). Essentially, his "dangerous" loading is one at which the receiving water would become eutrophic or remain eutrophic; his "permissible" loading is that which would result in the receiving water remaining oligotrophic or becoming oligotrophic if morphometry permitted. A mesotrophic loading would be considered one between "dangerous" and "permissible".

Note that Vollenweider's model may not be applicable to water bodies with short hydraulic retention times.

	Total Phosphorus		Total Nitrogen	
	Total	Accumulated	Total	Accumulated
grams/m^2/yr	1.02	0.68	21.4	13.3

Vollenweider phosphorus loadings ($g/m^2/yr$) based on mean depth and mean hydraulic retention time of Lake Ahquabi:	
"Dangerous" (eutrophic loading)	0.40
"Permissible" (oligotrophic loading)	0.20

V. LITERATURE REVIEWED

Anonymous, 1970. Lake Ahquabi brochure (camping and picnic facilities). IA Cons. Comm., Des Moines.

Harrison, Harry M., 1975. Personal communication (lake morphometry). IA Cons. Comm., Des Moines.

Mayhew, James, 1975. Personal communication (general information on Lake Ahquabi and watershed). IA Cons. Comm., Chariton.

Vollenweider, R. A., and P. J. Dillon, 1974. The application of the phosphorus loading concept to eutrophication research. Natl. Res. Council of Canada Publ. No. 13690, Canada Centre for Inland Waters, Burlington, Ontario.

VI. APPENDICES

APPENDIX A

LAKE RANKINGS

LAKE DATA TO BE USED IN RANKINGS

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P
1901	LAKE ACQUABI	0.062	0.335	469.333	8.600	8.200	0.009
1902	BIG CREEK RESERVOIR	0.046	6.465	436.500	16.867	14.800	0.011
1903	BLACK HAWK LAKE	0.185	0.130	488.167	49.740	15.000	0.020
1904	CLEAR LAKE	0.059	0.070	465.125	17.400	8.600	0.010
1905	LAKE DARLING	0.077	1.475	482.500	13.817	9.200	0.012
1906	LOST ISLAND LAKE	0.146	0.065	421.167	36.100	8.400	0.021
1907	LAKE MACBRIDE	0.061	2.035	458.444	17.067	15.000	0.010
1908	PRAIRIE ROSE LAKE	0.056	0.210	463.667	17.350	8.600	0.010
1909	RATHBUN RESERVOIR	0.071	1.170	475.889	12.039	14.000	0.008
1910	RED ROCK LAKE	0.180	1.880	473.400	14.730	14.000	0.104
1911	ROCK CREEK LAKE	0.065	1.400	480.500	18.367	8.400	0.007
1912	SILVER LAKE	0.193	0.565	482.667	95.300	10.000	0.034
1913	SPIRIT LAKE	0.041	0.090	422.667	12.622	9.000	0.007
1914	VIKING LAKE	0.075	0.130	459.000	26.033	14.200	0.017
1915	WEST LAKE OKOBOJI	0.046	0.060	380.444	7.722	15.000	0.017

PERCENT OF LAKES WITH HIGHER VALUES (NUMBER OF LAKES WITH HIGHER VALUES)

LAKE CODE	LAKE NAME	MEDIAN TOTAL P	MEDIAN INORG N	500-MEAN SEC	MEAN CHLORA	15-MIN DO	MEDIAN DISS ORTHO P	INDEX NO
1901	LAKE ACQUABI	57 (8)	50 (7)	43 (6)	93 (13)	100 (14)	79 (11)	422
1902	BIG CREEK RESERVOIR	89 (12)	0 (0)	79 (11)	57 (8)	21 (3)	50 (7)	296
1903	BLACK HAWK LAKE	7 (1)	68 (9)	0 (0)	7 (1)	7 (0)	21 (3)	110
1904	CLEAR LAKE	71 (10)	86 (12)	50 (7)	36 (5)	75 (10)	64 (8)	382
1905	LAKE DARLING	29 (4)	21 (3)	14 (2)	71 (10)	57 (8)	43 (6)	235
1906	LOST ISLAND LAKE	21 (3)	93 (13)	93 (13)	14 (2)	89 (12)	14 (2)	324
1907	LAKE MACBRIDE	64 (9)	7 (1)	71 (10)	50 (7)	7 (0)	64 (8)	263
1908	PRAIRIE ROSE LAKE	79 (11)	57 (8)	57 (8)	43 (6)	75 (10)	64 (8)	375
1909	RATHBUN RESERVOIR	43 (6)	36 (5)	29 (4)	86 (12)	39 (5)	86 (12)	319
1910	RED ROCK LAKE	14 (2)	14 (2)	36 (5)	64 (9)	39 (5)	0 (0)	167
1911	ROCK CREEK LAKE	50 (7)	29 (4)	21 (3)	29 (4)	89 (12)	96 (13)	314
1912	SILVER LAKE	0 (0)	43 (6)	7 (1)	0 (0)	50 (7)	7 (1)	107
1913	SPIRIT LAKE	100 (14)	79 (11)	86 (12)	79 (11)	64 (9)	96 (13)	504
1914	VIKING LAKE	36 (5)	64 (9)	64 (9)	21 (3)	29 (4)	32 (4)	250
1915	WEST LAKE OKOBOJI	89 (12)	100 (14)	100 (14)	100 (14)	7 (0)	32 (4)	428

LAKES RANKED BY INDEX NOS.

RANK	LAKE CODE	LAKE NAME	INDEX NO
1	1913	SPIRIT LAKE	504
2	1915	WEST LAKE OKOBOJI	428
3	1901	LAKE ACQUABI	422
4	1904	CLEAR LAKE	382
5	1908	PRAIRIE ROSE LAKE	375
6	1906	LOST ISLAND LAKE	324
7	1909	RATHBUN RESERVOIR	319
8	1911	ROCK CREEK LAKE	314
9	1902	BIG CREEK RESERVOIR	296
10	1907	LAKE MACBRIDE	263
11	1914	VIKING LAKE	250
12	1905	LAKE DARLING	235
13	1910	RED ROCK LAKE	167
14	1903	BLACK HAWK LAKE	110
15	1912	SILVER LAKE	107

APPENDIX B

CONVERSION FACTORS

CONVERSION FACTORS

Hectares x 2.471 = acres

Kilometers x 0.6214 = miles

Meters x 3.281 = feet

Cubic meters x 8.107×10^{-4} = acre/feet

Square kilometers x 0.3861 = square miles

Cubic meters/sec x 35.315 = cubic feet/sec

Centimeters x 0.3937 = inches

Kilograms x 2.205 = pounds

Kilograms/square kilometer x 5.711 = lbs/square mile

APPENDIX C

TRIBUTARY FLOW DATA

TRIBUTARY FLOW INFORMATION FOR IOWA 12/23/75

LAKE CODE 1901 AHGUABI LAKE

TOTAL DRAINAGE AREA OF LAKE(SQ KM) 12.8

TRIBUTARY	SUB-DRAINAGE AREA(SQ KM)	NORMALIZED FLOWS(CMS) JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	MEAN
1901A1	12.8	0.03	0.07	0.15	0.11	0.13	0.19	0.03	0.03	0.03	0.02	0.03	0.02	0.07
1901H1	5.8	0.02	0.03	0.07	0.05	0.06	0.08	0.01	0.01	0.01	0.01	0.01	0.01	0.03
1901Z2	7.8	0.02	0.04	0.08	0.06	0.07	0.10	0.02	0.01	0.02	0.01	0.02	0.01	0.04

SUMMARY

TOTAL DRAINAGE AREA OF LAKE = 12.8 TOTAL FLOW IN = 0.04
SUM OF SUB-DRAINAGE AREAS = 12.8 TOTAL FLOW OUT = 0.04

MEAN MONTHLY FLOWS AND DAILY FLOWS(CMS)

TRIBUTARY	MONTH	YEAR	MEAN FLOW	DAY	FLOW	DAY	FLOW	DAY	FLOW
1901A1	8	74	0.0	17	0.0				
	9	74	0.0	7	0.0				
	10	74	0.0	5	0.0				
	11	74	0.01	2	0.04				
	12	74	0.01	15	0.05				
	1	75	0.02	10	0.02				
	2	75	0.02	22	0.02				
	3	75	0.20	16	0.10				
	4	75	0.13	7	0.08	20	0.08		
	5	75	0.06	3	0.05	17	0.03		
	6	75	0.01	8	0.01	21	0.03		
	7	75	0.0	13	0.0				
1901H1	8	74	0.0	17	0.0				
	9	74	0.0	7	0.0				
	10	74	0.0	5	0.0				
	11	74	0.0	2	0.0				
	12	74	0.01	15	0.02				
	1	75	0.01	10	0.01				
	2	75	0.01	22	0.01				
	3	75	0.13	16	0.05				
	4	75	0.06	7	0.04	20	0.03		
	5	75	0.03	3	0.02	17	0.0		
	6	75	0.0	8	0.0	21	0.0		
	7	75	0.0	13	0.0				
1901Z2	8	74	0.0						
	9	74	0.0						
	10	74	0.0						
	11	74	0.01						
	12	74	0.01						
	1	75	0.01						
	2	75	0.01						
	3	75	0.16						
	4	75	0.07						
	5	75	0.03						
	6	75	0.01						
	7	75	0.0						

APPENDIX D

PHYSICAL and CHEMICAL DATA

STORET RETRIEVAL DATE 75/12/23

190101
41 17 30.0 093 35 32.0
LAKE ACQUABI
19151 IOWA

11EPALES
3

2111202
0016 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00010 WATER TEMP CENT	00300 DO MG/L	00077 TRANSP SECCHI INCHES	00094 CNDUCTVY FIELD MICROMHO	00400 PH SU	00410 T ALK CACO3 MG/L	00610 NH3-N TOTAL MG/L	00625 TOT KJEL N MG/L	00630 NO2&NO3 N-TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P
74/04/17	16 05	0000	12.3		32	37		104	0.060	1.100	0.520	0.009
	16 05	0005	11.4	10.0		77		104	0.040	0.800	0.470	0.011
	16 05	0013	10.2	9.6		145		104	0.060	0.700	0.520	0.009
74/07/02	13 50	0000	26.3	7.8	12	271	7.90					
	13 50	0005	25.9	7.7		271	7.80					
	13 50	0010	25.5	7.8		271	7.80					
74/09/25	11 30	0000	17.1	7.2	48	188	7.40	100	0.120	1.000	0.020K	0.009
	11 30	0005	17.0	6.8		187	7.41	103	0.130	0.800	0.020K	0.010
	11 30	0014	17.0	7.2		187	7.38	101	0.140	0.800	0.020K	0.009

DATE FROM TO	TIME OF DAY	DEPTH FEET	00665 PHOS-TOT MG/L P	32217 CHLRPHYL A UG/L	00031 INCDT LT REMNING PERCENT
74/04/17	16 05	0000	0.046	6.8	
	16 05	0005	0.060		
	16 05	0013	0.038		
74/07/02	13 50	0000		6.7	
74/09/25	11 30	0000	0.074	12.3	
	11 30	0005	0.064		
	11 30	0010			1.0
	11 30	0014	0.068		

K VALUE KNOWN TO BE
LESS THAN INDICATED

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APPENDIX E

TRIBUTARY DATA

STORET RETRIEVAL DATE 76/01/27

1901A1
41 17 40.0 093 35 45.0
UNNAMED STREAM
19151 15 INDIANOLA
0/AHQUABI LAKE
BANK SAMP BELO DAM IN LK AHQUABI ST PARK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/12/15	10 12		0.064	1.100	0.220	0.010	0.040
75/03/16	09 05		0.260	1.300	0.375	0.007	0.040
75/04/07	09 15		0.500	1.700	0.235	0.015	0.080
75/04/20	08 45		0.550	1.600	0.240	0.025	0.130
75/05/03	10 50		0.430	1.500	0.095	0.010	0.050
75/05/17	11 05		0.175	2.200	0.300	0.075	0.520
75/06/21	12 10		0.030	1.800	0.810	0.040	0.120

STORET RETRIEVAL DATE 76/01/27

190181
41 16 40.0 093 35 30.0
UNNAMED STREAM
19 15 INDIANOLA
T/AMQUABI LAKE
BRDG ON RD AT S EDGE OF LK AMQUABI ST PK
11EPALES 2111204
4 0000 FEET DEPTH

DATE FROM TO	TIME OF DAY	DEPTH FEET	00630 NO2&NO3 N-TOTAL MG/L	00625 TOT KJEL N MG/L	00610 NH3-N TOTAL MG/L	00671 PHOS-DIS ORTHO MG/L P	00665 PHOS-TOT MG/L P
74/12/15	10 42		0.240	1.200	0.230	0.005	0.040
75/04/07	10 00		1.650	1.550	0.315	0.040	0.140
75/04/20	09 05		1.400	1.600	0.240	0.025	0.110
75/05/03	11 05		0.960	2.100	0.230	0.025	0.150
75/05/17	11 25		9.800	1.950	0.175	0.145	0.370

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